UNIVERSITI TEKNOLOGI MARA

RHEOLOGICAL AND MECHANICAL PROPERTIES OF YTTRIA STABILIZED ZIRCONIA (YSZ) PRODUCED BY CERAMIC INJECTION MOULDING

MAHFUZAH BINTI ZAINUDIN

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Mahfuzah Bt Zainudin
Student I.D. No.	:	2014435524
Programme	:	Master of Science (Mechanical Engineering) – EM750
Faculty	:	Mechanical Engineering
Thesis	:	Rheological and Mechanical Properties of Yttria Stabilized Zirconia (YSZ) Produced by Ceramic Injection Moulding Process.
Signature of Student	:	.....
Date	:	March 2017

ABSTRACT

Powder Injection Moulding (PIM) is a promising approach to producing a near net-shape product of intricate geometry with cost-effective production. PIM by using ceramic powders has been studied recently due to interest as ceramic biomaterials. Yttria Stabilized Zirconia (YSZ) powders are renowned materials with their, biocompatibility, superior dimensional stability and excellent mechanical properties resulting from mechanisms of transformation toughening. The focus of this study is to fabricate root pins for dental implantation structure through Ceramic Injection Moulding (CIM). 3 mol% YSZ powders were used to mix with binder components that consist of palm stearin (PS) as a primary binder and polyethylene (PE) as a backbone binder in 60:40 ratios. Four different powder loadings were prepared in this study; 57, 58, 59 and 60 vol. % based on critical powder volume percentage (CPVP) experiment. The homogeneity of the feedstocks was evaluated via torque rheometry data and scanning electron microscopy (SEM) observation. The flow ability of the feedstock were determined through rheological characteristic which are the relationship of viscosity and shear rate formed pseudoplastic behaviour, the flow behaviour index value (n) is below than 1 and lower activation energy (E). Then, all feedstocks were injected in a screw thread shape and rectangular bar mould for further experiment. All moulded specimens were embedded into alumina powder (wicking agent) before undergoing thermal debinding process at 550°C to remove the binders and pre-sintering at 1100°C was carried out simultaneously after debinding process in the same furnace. The parts were subsequently sintered in the furnace up to 1450°C for 3 hours without wicking agent with 3°C/min heating rate. The characterization of sintered parts, physical properties, and mechanical properties was performed. It is expected that, low powder loading specimens (57 vol. %) had lower viscosity, strength, density and hardness but higher in porosity compared to higher powder loading specimens (58 vol. %, 59 vol. % and 60 vol. %). The elastic modulus of compressive strength and hardness for 60 vol. % specimens was 4.79 ± 1.24 GPa and 398.5±10.4 HV respectively. Overall, root pins for dental implantation structure was successfully fabricated via CIM technique using PS as the binder system.

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